INDOOR AIR QUALITY ASSESSMENT

Revere Public Library
179 Beach Street
Revere, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Mayor Thomas Ambrosino, the Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality issues and health concerns at the Revere Public Library (the library) in Revere, MA. On April 27, 2001 a visit was made to this building by Cory Holmes of the Emergency Response/Indoor Air Quality (ER/IAQ) Program, BEHA, to conduct an indoor air quality assessment. Robert Rice, Revere Public Library Director, accompanied Mr. Holmes during the assessment. This request was prompted by reports of general indoor air and odor complaints in the basement/ground floor children's area.

The library is a two-story red brick and steel frame structure built in 1902 (see Picture 1). The second floor contains a rotunda and is currently used for storage. The first floor contains the circulation desk, reading areas and main stacks of the library. The basement/ground floor contains the periodical section, employee break room, boiler room and the children's library, which is located adjacent to the boiler room.

According to Mr. Rice the library is tentatively scheduled for complete structural and heating, ventilation and air conditioning (HVAC) renovations between the spring of 2002 and fall of 2003. Library operations, staff and materials will be temporarily relocated to another facility during the renovation project.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI Q-Trak, IAQ Monitor, Model 8551.

Results

The library has an employee/volunteer population of approximately 10 and can have up to 200 visitors on a daily basis. The tests were taken under normal operating conditions. Test results appear in Tables 1-2. Air samples are listed in the tables by location that the sample was taken.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were slightly elevated above 800 parts per million (ppm) in two of twelve areas surveyed, which indicates adequate air exchange in most areas. The library does not have a modern mechanical ventilation system, but relies on openable windows to provide airflow. Heat is provided by wall mounted radiators during the heating season.

Ventilation was originally provided by a natural/gravity ventilation system that has been abandoned. Fresh air to the main library was provided by a series of louvered vents. Each wing of the library has an approximately 3' x 3' grated air vent at floor level (see Picture 2), which is connected by ductwork to a "hearth"-like opening in the basement. One of these vents was sealed; the other was not.

Air movement was provided by the stack effect. In this type of ventilation system, the heating elements warm the air, which rises up the ventilation shafts. As the heated air rises, negative pressure is created, which draws cold air from the basement area into the heating elements. This system was designed to draw air from two sources in the basement: fresh air from a hinged window-pulley system on the exterior wall of the building and return air from the exhaust ventilation shafts. These sources of air were mixed in the basement prior to being drawn into the heating elements. The percentage of fresh air to return air was controlled by the hinged window-pulley system. The chains of the pulley system were designed to be set to lock the hinged window at a desired angle to limit fresh air intake.

Unless the ventilation system is restored to its original design by restoring control systems and openable basement windows, the sole source of ventilation in the building is openable windows. In light of the forthcoming renovations and installation of a modern mechanical HVAC system, restoration of the original natural gravity ventilation system at this time is impractical. Steps to abandon the system should be part of the renovation plan.

The Massachusetts Building Code requires a minimum mechanical ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993, SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation.

Temperature readings on the day of the assessment ranged from 69° F to 70 ° F, which were very close or within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. Complaints of being too cold during the heating season were reported at the circulation desk. This area is located on the main floor, center facing the front entrance. The front entrance is in the main path of entry/exit into the building and is made up of two sets of swinging doors that appear to be of extreme age. These doors are not airtight; BEHA staff noted spaces around the doors through which light and drafts were noted (see Picture 3). In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, temperature control is often times difficult in an old building without a mechanical ventilation system.

The relative humidity in the building was slightly below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 30 to 37 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas on the second floor had water-damaged walls and/or ceilings, which is evidence of roof or plumbing leaks. Water intrusion was evident by the presence of efflorescence (e.g., mineral deposits) and water-damaged wall and ceiling plaster (see Pictures 4 & 5). Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, water evaporates, leaving behind white, powdery mineral deposits. Water-damaged building materials can provide a source of microbial growth, especially if they are moistened repeatedly. These materials should be replaced after a water leak is discovered.

An active leak was reported in the mezzanine storage room and a bucket was stationed below to collect rainwater (see Picture 5). Possible mold growth on water damaged ceiling plaster was observed in this area (see Picture 6). Mr. Rice reported that a roofing contractor has visited the site a number of times and is in the process of tracing the source of the leak.

A water cooler was observed on the carpet in the business office and in the north basement classroom (see Picture 7). The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed. To avoid water damage to carpeting and/or potential mold growth, a water-resistant material such as plastic or rubber matting should be installed beneath this water cooler.

Water vapor was observed collecting inside the double-paned window glass in a number of areas (see Picture 8). This indicates that the window's water seal is no longer intact. Water penetration through windows/frames can lead to mold growth under certain conditions. Replacement of caulking and repairs of window leaks are necessary to prevent further water penetration. Existing windows are scheduled to be replaced during the renovation project.

The children's library contained a dehumidifier. Humidifiers and dehumidifiers contain reservoirs that hold standing water. Dehumidifiers should be emptied and cleaned as per the manufacturer's instructions to prevent bacterial and mold growth. The dehumidifier in the children's library was full at the time of the assessment.

Other Concerns

Several other conditions that can potentially affect indoor air quality were also identified. As discussed previously, the children's library is located directly adjacent to the boiler room. The boiler room contains a large oil-fired furnace and two 500-gallon oil tanks (see Pictures 9 & 10), and is separated from the children's library by a wood-framed, sheetrock wall equipped with a door (see Picture 11).

During operation, the oil burner/furnace generates heat and odors associated with the combustion of fossil fuel. This was evidenced by odor complaints from a library occupant, several minutes after the boiler had "fired-up" while BEHA staff and Mr. Rice were examining conditions in the boiler room.

Due to differences in temperature and pressurization between rooms, air currents are created that can migrate from the boiler room into the adjacent children's library carrying odors, waste heat and particulates. In addition, petroleum products contain volatile organic compounds (VOCs), which can be irritating to the eyes, nose and throat. A number of different pathways were identified including spaces around doors, walls, utility holes and above ceiling tiles in the ceiling plenum (see Pictures 11 & 12). These pathways can serve as egress for vapors, fumes, dusts and odors between areas.

Several areas contained window-mounted air conditioners. Portable air conditioners are normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter. BEHA staff inspected the filter to one of the units in the children's library and found it coated with dirt/dust. A debris-saturated filter can obstruct airflow and may serve as a reservoir of particulates that can be re-aerosolized and distributed to occupied areas when the unit is activated.

Conclusions/Recommendations

Symptoms and complaints reported to the BEHA are consistent with conditions observed at the time of the assessment. The primary complaints of boiler room/fuel odors result from the close proximity of the children's library to the boiler room and potential pathways of odor migration identified. In view of the findings at the time of this visit, the following recommendations are made:

1. In order to prevent boiler room/fuel odors from penetrating into the children's library walls separating the children's library from the boiler room, the area needs to be made as "air-tight" as possible. This will include:
    - sealing all utility holes with an air-tight, foam-like material (see Picture 13);
    - ensuring that all wallboard joints and seams along boiler room/library are sealed so no spaces exist between the walls and the ceiling;
    - sealing spaces around doors with weather stripping and installing a door sweep.

2. Continue plans for renovation of the building structure and the installation of a modern mechanical HVAC system.

3. Seal original gravity feed exhaust vents at both ends to prevent drafts. Ensure all systems within airshafts are deactivated. Regulate airflow with the use of openable windows to control for comfort. Care should be taken to ensure windows are properly closed at the close of business to avoid water damage, the freezing of pipes and potential flooding.

4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

5. To avoid drafts, seal main entrance with weather stripping and a door sweep. Reactivate radiator in vestibule to temper incoming air.

6. Repair and/or replace thermostats as necessary to maintain control of comfort.

7. Continue to work with roofing contractor to identify and repair any existing water leaks and replace any remaining water-stained building materials. Examine above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.

8. Relocate or place tile or rubber matting underneath water coolers in carpeted areas.

9. Clean and maintain dehumidifiers as per the manufacturer's instructions.

10. Change/clean filters for window-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

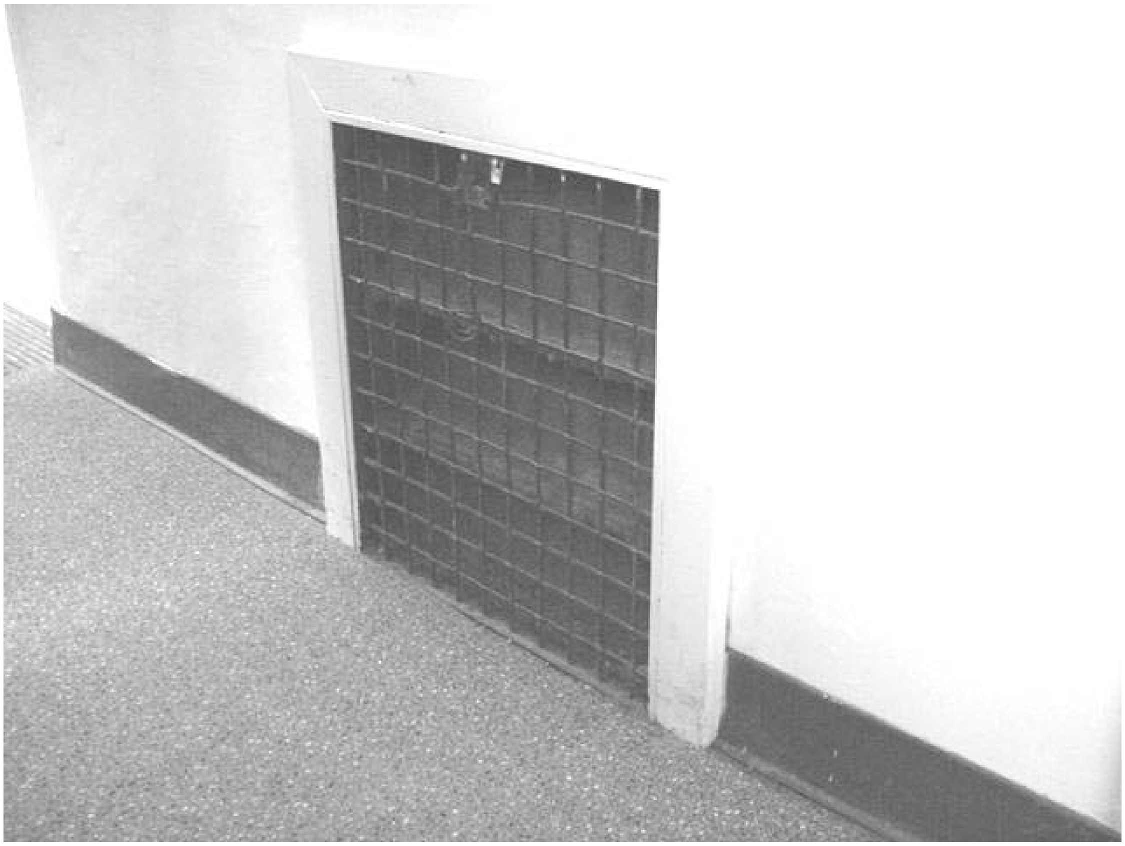
OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Picture 1

Revere Public Library (2001), Built in 1902

Picture 2



Natural/Gravity Feed Vent

Picture 3

Circulation Desk and Front Entrance Note, Spaces around Doors

Picture 4

Water Damaged Ceiling Plaster (Efflorescence)

Picture 5

Water Damaged Ceiling Plaster and Bucket to Collect Rainwater in Mezzanine Storage Room

Picture 6

Close-up of Water Damaged Ceiling Plaster and Potential Microbial Growth as Indicated by Dark Stains

Picture 7

Water Cooler on Carpeting

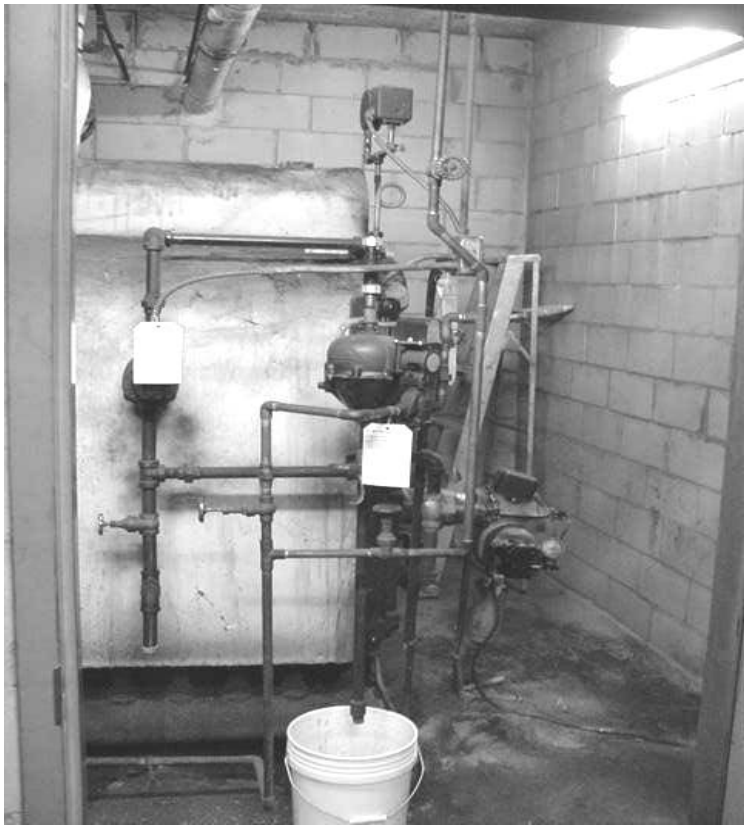
Picture 8

Condensation between Window Frames Indicating Faulty Seal

Picture 9

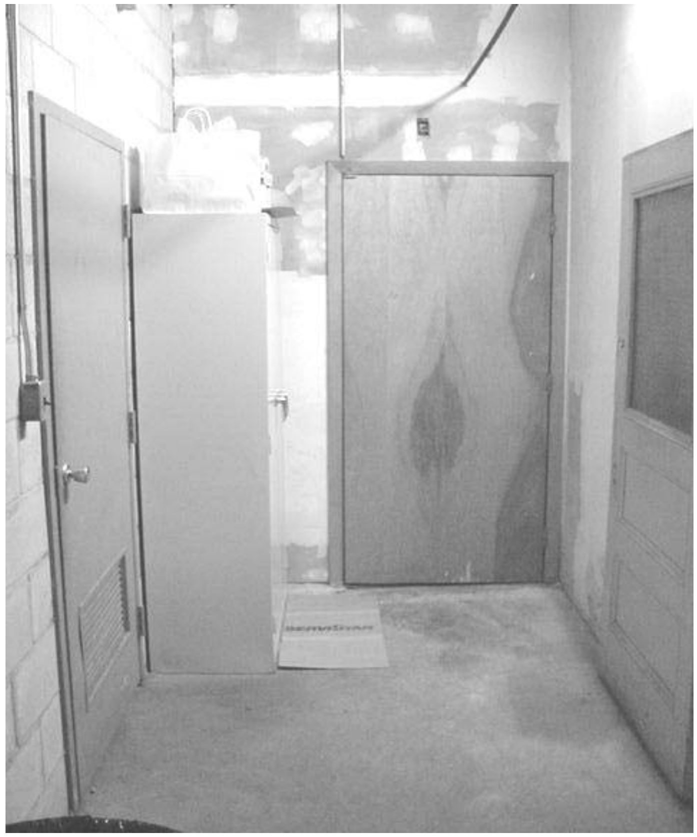
(2) 500-Gallon Oil Tanks Located in Basement/Boiler Room

Picture 10



Boiler Plant Adjacent to Children's Library

Picture 11



Sheetrock Wall Separating Boiler Room from Children's Library
Note Spaces around Door

Picture 12

Utility Holes in Sheetrock Wall Boiler Room/Children's Library

Picture 13

Foam Insulation Material around Pipes in Boiler Room

TABLE 1

Indoor Air Test Results – Revere Public Library, Revere, MA – April 27, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	450	62	42					Weather conditions: sunny, slight breeze
Storage Room-Mezzanine Level	842	70	35	0	Yes	No	No	Water damaged ceiling-possible mold growth, active leaks with heavy rain, carpet
Stairwell								Efflorescence-wall/ceiling junction
Stack Area	630	70	30	0	Yes	No	No	Natural gravity vents (2)-one sealed
Tech Services	831	70	32	1	Yes	No	No	
Secretary's Office	780	70	32	0	Yes	No	No	Water cooler on carpet, floor vent
Main Circulation Desk	608	69	32	1	No	No	No	Spaces around doors, 2 working fireplaces-not used
Main Area – East	589	69	32	1	Yes	No	No	Ceiling fan, fireplace
Main Area – West						No	No	Ceiling fan, fireplace
Rotunda	630	69	32	0	No	No	No	Closed to public, dusty/dirty, currently used for temporary storage

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Revere Public Library, Revere, MA – April 27, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Craft Room	643	69	36	1	Yes	No	No	Window mounted A/C
Restroom					Yes	No	No	No mechanical exhaust
Kitchen	642	70	37	0	No	No	No	Main frame, refrigerator, stove (unused), microwave
Staff Restroom					No	No	Yes	
Main Children's Area	590	69	37	1	Yes	No	No	Carpet, 2 window mounted A/C-dusty filters, photocopier
Story Room	614	69	37	0	No	No	No	Carpet, window mounted A/C, dehumidifier-full/unplugged
Children's Area Office	628	70	36	1	No	No	No	
Boiler Room Notes					Utility holes, spaces in wallboard, weather stripping, door spaces, foam insulation			

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